Highly Effective Digital Model Design and Practice for Deep Teaching Evaluation

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Abstract. Education instills ideals and aids in the overall growth of society. It allows people to shape themselves into more fiscally responsible contributors to society. Student evaluation of teaching is an important part of the management process of the digital campus, which is of great significance to the improvement of teaching quality and the implementation of teaching supervision and management. Conventional teaching evaluation mechanisms are based on students' feedback, which is time consuming and not accurate. Hence, this research work proposes a 5-level teaching evaluation system that utilizes information technology to efficiently and accurately establish a deep teaching evaluation system centered on objective data that can be further analyzed and processed. This teaching evaluation model dynamically analyzes and mines teaching evaluation data, reflecting teaching level more truly and objectively and improving teaching effectiveness. Experimental results show that the proposed model based on a deep evaluation system is statistically significant and is used to assess student quality quickly and accurately.

Keywords: Correlation analysis, Digital Campus, Evaluation System, Statistical Analysis, Teaching Effectiveness, Teaching Evaluation.

1 Introduction

Student evaluation of teaching is an important part of the school management process, which is of great significance to the improvement of school teaching quality and the implementation of teaching supervision and management. Student evaluation of teaching opens a channel for students to express education and teaching opinions and suggestions, which helps to improve students' satisfaction and teachers' teaching quality. Many foreign schools even regard it as a routine system of school teaching management. The management of colleges and universities in China has been introduced since the 1980s. Established evaluation indicators based on the rationality, effectiveness, and impact factor analysis of student evaluation of teaching.

In order to improve the effectiveness of evaluation, the previous teaching evaluation focused on the construction of teaching evaluation index system. In addition to requiring the scientific and guidance of teaching evaluation, Chen [1] added the principle of integrity to make up for the deficiency of many indicator systems that only focus on classroom teaching links and ignore pre-class preparation and after-class follow-up feedback.

Process mining technology aims to automatically generate process models by analyzing events, thereby helping to design and redesign process models. Previous methods focused on mining

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the behavior described by logs. It ignores the structural nature of the process model itself. Zhuo et al. [2] combined process complexity with process mining algorithms based on genetic programming. They proposed a measure of process structural complexity, converted it into complexity fitness, and introduced it into the fitness function of genetic programming to achieve the use of genetic programming. The application of this improved adaptive genetic programming robust scheduling algorithm in the implementation of university sports evaluation, not only makes the university sports evaluation management system more intelligent, but also improves the reasonable configuration of sports teaching.

The evaluation system centered on the construction of indicators establishes an indicator system based on the establishment of a large number of standards, then designs weights according to indicators, then carries out actual measurement, and finally feeds back and modifies the results. There are mainly qualitative and quantitative indicators for teaching evaluation, with their advantages and disadvantages selected according to the specific situation.

The establishment of an indicator system is an important part of the evaluation model centered on the indicator system. In order to make the teaching evaluation process more complete and persuasive, we even extended our horizons to extracurricular activities. Moreover, the hierarchy of indicator items includes the first level, the second level, and even the third level. In the selection of the best indicator items, neither too many indicator items will lead to careless filling, nor too few indicator items will lead to incomplete evaluation. Haijie et al. [3] proposed a method combining resolution analysis and factor analysis. Aimed at the problem that the current teaching evaluation index system cannot keep up with the needs of the times and is not adaptable to all disciplines, Wenguo et al. [4] suggested using a dynamic index database that can be added, deleted, and modified at any time.

The evaluation of college English classroom teaching is currently one of the key issues discussed by various schools. With the rapid development of remote network teaching based on computer technology, a large number of video and audio teaching resources are presented to learners through network transmission. Through network transmission of video and audio assistance, the audience of network teaching is expanded, which is conducive to achieving digital, informational, lifelong, and new educational goals. Shang [5] proposed an evaluation model based on the Internet of Things technology of machine learning, and verified its feasibility.

At present, there are many problems in college students' evaluation of teaching, such as unscientific indicators, unreasonable data processing, and inadequate application of evaluation results, which seriously affect the role and value of college students' evaluation of teaching. It is mainly manifested in:

- Lack of systematic and scientific teaching evaluation form design

  The teaching evaluation model centered on the indicator system includes relevant indicators such as teaching content, teaching attitude, teaching effect, and teaching methods, and gives them different weights. Such as careful preparation of lessons, familiarity with teaching materials, complete lecture notes, strict organization of teaching in accordance with the syllabus and teaching schedule, punctual starting and ending of classes, and careful teaching, and other relevant indicators. However, these indicators are relatively empty and indistinct, and have no operational or practical significance. Students lack a reliable basis in the specific scoring process, and are more arbitrary [6].

- The operability of the teaching evaluation index design is not strong

  At present, in the design process of teaching evaluation indicators, there are usually problems of operability. Because the design of teaching evaluation indicators is to pursue comprehensiveness as much as possible, which leads to strong subjectivity and randomness. It is difficult to clarify the objectives of teaching evaluation with conceptual, abstract, and general descriptions. Students cannot grasp the key points of teaching evaluation and cannot carry out teaching evaluation activities in a targeted manner, lacking practicality and operability [7].

- Serious distortion of teaching evaluation results

  The implementation of the teaching evaluation system is very restrictive, which leads to college students' resistance easily. Many students only treat teaching evaluation activities as a task that they have to complete in a hasty manner, resulting in the fact that the teaching evaluation effect of college students cannot truly reflect the teaching situation of teachers [8].

Students' evaluation of teaching in colleges and universities can strengthen teaching management and improve teachers' teaching levels. At present, college students' feedback on teaching evaluation is not specific and accurate. How to efficiently and accurately establish an evaluation system based on objective data that can be further analyzed and processed with the help of information is the content that digital campus has been exploring. Yang uses information entropy to process teaching evaluation results. Through deep analysis, finding the feedback information implicit in the scoring results can help college teachers analyze the specific causes of teaching problems, thereby improving teaching standards, and also provide scientific and reliable basis for college teaching management [9].

This paper introduces a 5-level grading system centered on teaching tasks for teaching evaluation, which has the following advantages:

1)Simple operation.

2)For complex and fuzzy indicators, the 5-level rating system is directly used, which is convenient for the quantitative analysis of computer background with binary logic. It can effectively and accurately reflect the essential characteristics of teaching evaluation.

3)The larger the teaching capacity, the more students, and the more fair the teaching evaluation results.

Compared with the centennial teaching evaluation system of the teaching evaluation model centered on the index system, the grade system adopted is more convenient for the establishment of teaching evaluation data on the digital campus and for analysis and processing. This paper establishes a 5-level teaching evaluation system centered on teaching tasks, dynamically analyzes and mines the teaching evaluation data, and more truly and objectively reflects the teaching effectiveness of teachers.

The following is a summary of the remaining sections of this article. Section 2 recapitulates the state-of-the-art works associated with teaching evaluation mechanisms. Section 3 elaborates on the stages of the proposed deep evaluation model. Section 4 discusses the construction of deep evaluation indicators. The statistical analysis and the experimental evaluation are discussed in Section 5. Section 6 concludes the research work.

2 Related Work

Teaching evaluation enables the identification of flaws in teaching methods, revealing those who need additional training to deliver lessons efficiently. The preparation of programmes, trust-building among administrators and coworkers, and professional growth of teachers are all significantly influenced by teaching evaluation. This section elucidates the related works concerned with teaching evaluation. The deep learning evaluation for an online course is carried out using the SOLO taxonomy [10]. This is very useful for measuring learning outcomes and assessment. The preliminary analysis of transcript data can be done with the help of this approach. Gathering transcript data that is specific to a learning outcome offers instant pointers to the success or failure of the course.

O'Brien [11] studied the present status of teacher evaluations, which expresses the purpose of how the teaching evaluation system needs to be transformed by amalgamating technology to rationalize the practice and thus enhance teaching and learning. Basically, the higher educational system needs to clarify the teaching goals and cope with the quality of students at the same time. Li [12] addressed the importance of a multidimensional curriculum evaluation system with the help of social evaluation, in-class evaluation, enterprise evaluation, industry evaluation, and after-class evaluation. This method will be used to enhance the graduates' professional skills so as to achieve better professional quality.

John et al. [13] done a comprehensive review of the use of Artificial Intelligence (AI) in educational assessment. This review investigates core applications related to education, such as computerized test and automated essay scoring systems. The benefits of machine learning and big data analytics in educational assessment are also discussed. Alegre and Berbegal-Mirabent [14] presented an overview of different student evaluation systems, and highlighting its pros and cons when incorporating them in online environments. This work also suggests methodologies to identify the challenges, effective practices in online assessment and capture the student's opinion about the various forms of assessment.

He and Fu [15] built the teaching evaluation system to improve the engineering cost of the teaching evaluation algorithm along with an in-depth learning approach. This will be useful for achieving the research goal of engineering cost-effective teaching assessment and regulating the teaching evaluation index. Experimental studies show that this work enhances student grades and skills. Conventional methods in teaching evaluation made use of subjective methods which leads to imprecise results. Zhuang et al. [16] observed that the concentration level of the student plays vital role in teaching evaluation. This work uses deep learning model to attain scientific evaluation of the teaching quality. The head-up rate and facial expression data are used to model an intelligent system.

Automated evaluation methods in English writing are gaining more attention and more common. An AI-based method such as Natural Language Processing (NLP) is used to quickly score and update students' writing. Wang and Huang [17] researched the effect of an automated evaluation system and cognitive style on college-level writing training. This work concludes that the introduction of an IT-based method enhances the course teaching and improves the students' writing skills. Zhou and Zhan [18] investigated the possibilities of applying data mining techniques to evaluate the teaching quality. The rationality and subjectivity of current teaching qual-

ity are evaluated using an association rule mining algorithm. The relevant factors used for assessing the teaching quality were identified. This approach will be beneficial to the administrators of higher education in making effective decisions.

Li and Zhang [19] studied the research progress and scenarios of big data based teaching evaluation mechanisms. This study observes that the interaction and cooperation between student and teacher should be enhanced to improve cohesive research groups. This work also discussed the importance of AI, big data, MOOCs and smart classes in student and teacher evaluation. In the recent past, deep learning algorithms have been used in several applications for solving the classification and prediction problem. Liu et al. [20] studied the three levels in application of curriculum learning such as data, task and model. The evaluators created utilizing curricular learning approaches in several disciplines are summarized in this article. This work also suggests how to prefer the suitable evaluation system.

3 Deep Evaluation Model

One of the major challenges faced by the management process of a digital campus is teaching evaluation. State-of-the-art research work related to the evaluation of teaching based on student feedback is time-consuming and not accurate. The proposed deep evaluation model is organized into several stages, which are illustrated in Fig. 1. First, the objectives of Teaching and Learning the course are framed. This focuses on learners' ability to comprehend, exchange, apply, and address issues, with an emphasis on the enhancement of skills related to higher-order thinking. Rich and diverse learning resources are provided, and a good atmosphere for learning is facilitated. To effectuate in-depth learning, pragmatic teaching and custom-made guidance are given. The collaborative learning is systematized and concentrated on improving the student's knowledge. Please refer to **Fig. 1**.

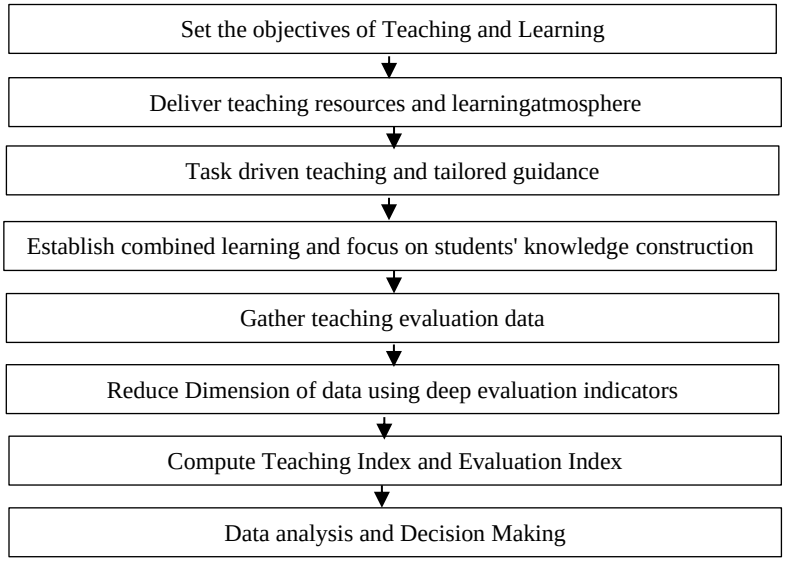

Fig. 1. The proposed deep evaluation model (Author's drawing)

The effectiveness of teaching is influenced by several factors. These factors are collected for teaching evaluation. These data are of high dimension. The dimension of these data is reduced by using the proposed deep evaluation indicators. The relationship between these indicators is identified, and the teaching and evaluation indexes are computed. Finally, data analysis is used to assess the association between the teaching index and evaluation index and the distribution of evaluation scores. This will be beneficial for making better decisions.

4 Construction of deep evaluation indicators

There are many factors that affect the effectiveness of teaching evaluation. The influencing factors of the effectiveness of student evaluation of teaching can be divided into subjective and objective factors, positive and negative factors, controllable factors, and uncontrollable factors from different angles. Research on the effectiveness of teaching evaluation must begin with dimension reduction. Because data dimensionality reduction can not only solve the "dimension disaster", alleviate the current situation of "rich information and poor knowledge", and reduce complexity. It can also better understand and understand data.

There are many methods of data dimensionality reduction, which can be divided into linear dimensionality reduction and nonlinear dimensionality reduction according to the characteristics of the data. According to whether or not to consider and use the monitoring information of the data, it can be divided into unsupervised dimensionality reduction, supervised dimensionality reduction, and semi-supervised dimensionality reduction. According to the structure of the data, it can be divided into global dimensionality reduction, local dimensionality reduction, and global and local dimensionality reduction.

4.1 Teaching Evaluation Model

In order to reduce the dimension of teaching evaluation, this paper is based on the use of a 5-level scoring system to achieve students' evaluation of teachers. Because the 5-level scoring system has the following advantages:

1) It is simple and feasible, and the meaning of each choice is clear;

2) It can avoid errors that tend to be too moderate, strict, or lenient and reduce the cost of teaching evaluation;

3) The results of teaching evaluation are easy to quantify.

For example, excellent is equal to 5 points, good is equal to 4 points, fair is equal to 3 points, dissatisfied is equal to 2 points, and very dissatisfied is equal to 1 point. Therefore, after setting the weight of each evaluation standard, the teaching status of teachers can form quantitative indicators, including horizontal comparisons among teachers.

Table 1. Teaching evaluation data of teachers in various subjects (Author's drawing)

Teacher	Course hours	Time consuming	Students attended class	Evaluation index	Teaching index
633	430	286.66	257	4.81	41.9864
209	234	156.0	128	4.89	24.8518

702	216	144.0	128	4.91	22.6418
815	216	144.0	128	4.84	22.5531
838	216	144.0	128	4.73	21.7779
008	216	144.0	128	4.63	21.3137
902	180	120.0	67	4.96	21.2159
713	126	84.0	61	4.85	12.3619
299	108	72.0	67	4.91	11.8487
914	108	72.0	67	4.57	11.0091

As shown in **Table 1**, the total number of teachers' work in three semesters and the corresponding teaching evaluation data. Taking teacher no. 633 as an example, the detailed information on the teaching workload for three semesters is shown in **Table 2**.

Table 2. Teaching Task List of Teacher no.633 in Three Semesters (Author's drawing)

Serial	Course	Class	Task no.	Semester
1	hi02	Z1804	4	1
2	hi03	Z1803	119	2
3	hi03	Z1804	120	2
4	hilevel	Z1801	157	2
5	hilevel	Z1802	171	2
6	hi04	Z1803	179	3
7	hi04	Z1804	180	3

The class, teacher, and course only determine one teaching task, as shown in **Table 2**, which is the teaching task of teacher no. 633 for three semesters.

In the first semester, the teacher no. 633 took the hi02 course for class Z1804 in the first semester teaching task 4. There are four teaching tasks in the second semester, namely 119, 120, 157, and 171. 119 and 120 are the same course hi03 in different classes Z1803 and Z1804; 157 and 171 are another course, hilevel, in different classes Z1801 and Z1802. There are two teaching tasks in the third semester, 179 and 180. Take the hi04 course in different classes, Z1803 and Z1804.

Table 3. 23 Students' Evaluating Score to Teacher no.633 with Task 119 (Author's drawing**)**

Serial	Score	Student	Serial	Score	Student
1	-1	520170069	**13**	5	520180074
2	5	520180014	**14**	5	520180081
3	5	520180020	**15**	4	520180088
4	5	520180022	**16**	4	520180093
5	5	520180023	**17**	1	520180097
6	5	520180025	**18**	4	520180098
7	5	520180048	**19**	5	520180099
8	5	520180049	**20**	4	520180100
9	5	520180051	**21**	5	520180104

10	5	520180060	**22**	5	520180119
11	5	520180061	**23**	5	520180121
12	5	520180073			

As shown in **Table 3**, most students give a score of 4-5 points to teacher no. 633 using the 5-level system. In order to improve the objectivity of teaching evaluation, it is possible to set the evaluation of very few students as invalid. The teaching evaluation score of 520170069 for middle school students in the table is set to -1, which means that the student needs to be kicked out due to factors such as absenteeism or failing the exam.

4.2 Dimension of Teaching Evaluation

As shown in **Table 1**, each teacher is evaluated on five dimensions: course hours, time-consuming, students attending class, evaluation index, and teaching index. Class hour is an indicator of workload. Each class hour is defined in the course design, and is generally related to the credits of the course. Each school has different definitions of class hours, ranging from 40 minutes, 45 minutes, 50 minutes, and even 55 minutes. In order to calculate the accurate teaching time of teachers in a certain period of time (usually in terms of semesters), the teaching evaluation system will convert it into accurate minutes according to the timetable containing work and rest time. And the time-consuming nature of the second indicator.

Students attending class refers to the number of teaching students, and the fixed class schedule is the total number of teaching classes. Open course selection refers to the number of students who choose courses. In open management, the number of students attended class is related to the popularity of teachers.

The evaluation index is the average of the students' scores on the teaching according to the 5-level system. Among the above indicators, the course hours are related to the workload, and the students attending class are related to the quality and quantity. The evaluation index is a quality index, which is a comprehensive teaching evaluation index. The teaching index of each teaching task is based on the following formula (1):

$$Teaching\ Index = \frac{time-consumed \times students\ attended\ class \times evaluation\ index}{1000} \qquad (1)$$

The total teaching indexes of a period are the sum of the teaching indicators of all teaching tasks in that period. Teaching indexes are an important indicator because they not only reflect the quality of teachers' teaching but also the quantity of teachers' teaching. As shown in **Fig. 2**, it reflects the teaching indexes of 10 teachers in three semesters.

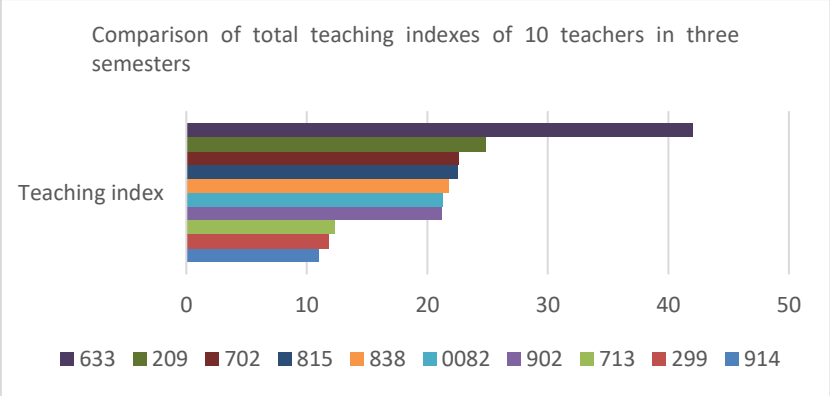

Fig. 2. Comparison of teaching indexes of teachers in three semesters (Author's drawing)

In the figure, the teaching indexes of each teacher are the sum of the teaching index of each teaching task. For example, the teaching indexes of teacher no. 633 are the sum of the teaching index of the seven teaching tasks shown in **Table 2**.

5 Data Analysis and Experimental Results

In this section, a detailed experimentation on statistical data analysis of teaching evaluation is described in terms of finding the correlation between the evaluation index and the teaching index and the distribution of evaluation scores in teaching tasks. This research also compares the features of deep evaluation model with those of the traditional evaluation model across the use of a 5-level scoring system with the deep evaluation model to achieve students' evaluation of teachers.

5.1 Correlation between Evaluation Index and Teaching Index

Among the five dimensions of teaching evaluation such as course hours, time-consuming, students attended class, evaluation index, teaching index, evaluation index and teaching index are related to quality. This best reflects the teaching level of teachers. Compared with the teaching evaluation of students, the teaching index can more comprehensively reflect the value of teachers. The relationship between the evaluation index and the teaching index is shown in **Fig. 3**.

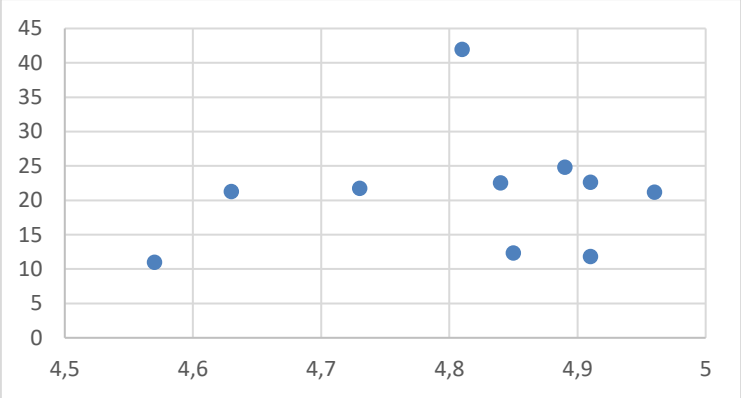

Fig. 3. Relationship between evaluation index and teaching index (Author's drawing)

The higher the evaluation index, the more popular teachers are with students. The more popular teachers are the more students they teach. In an open educational administration, the positive correlation between the evaluation index and the teaching index will be stronger.

5.2 Analysis of the Distribution of Evaluation Scores in Teaching Tasks

For all teaching tasks assigned by teacher no. 633 in three semesters, students will give them 1–5 points. Mostly distributed in 4,5 points, especially 5 points. It shows that most students approve of teacher no. 633, which is excellent. Take the two teaching tasks 119 and 120 in the second semester as an example. These two tasks belong to two different classes of the same course. As shown in **Fig. 4**, the data on students' evaluations of teaching are illustrated.

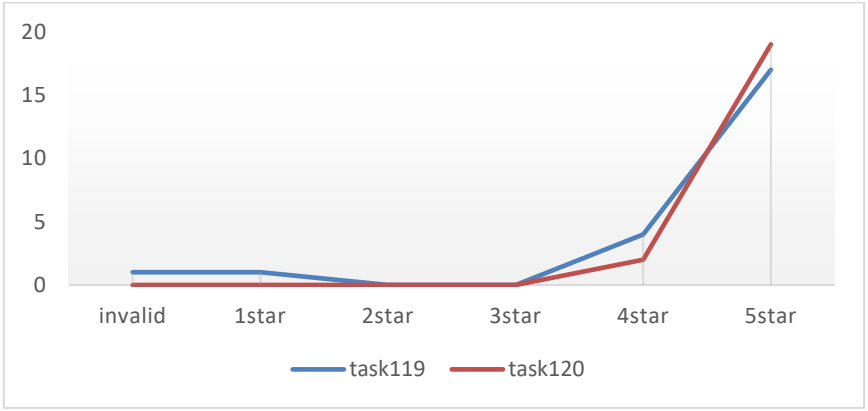

Fig. 4. Teacher 633's evaluation score of two tasks in the same semester (Author's drawing)

Teachers take classes at different times, and the evaluation data is different. For the same course in different classes, the teaching evaluation data is slightly different.

5.3 Statistical Analysis

Consider the teaching method with no differences in traditional performance as the control. The course uses the proposed deep evaluation model, which is considered to be class A as the experimental class and class B as the control class. Experimental classes make use of five dimensions such as course hours, time-consuming, students attending class, evaluation index, and teaching index for teacher evaluation. Class B follows the conventional method to evaluate teaching for the courses taught. Class A and Class B with generally the same initial settings are compared and analyzed, and the evaluation is conducted using a deep evaluation model for Class A and conventional evaluation mechanisms for Class B. To compare the performance of the deep evaluation model with the conventional approach, an examination is conducted. The evaluation is done, and the resultant performance is tabulated. There will be an evident gap between these two classes. This is illustrated in Table 4.

Table 4. Class A and Class B Result Comparison

Class	Number of People	Test Marks			
		Excellent (%)	Pass (%)	Highest Score	Lowest Score
A	100	43.25	84.35	99	55
B	100	29.25	70.21	94	40

$$d = \frac{\overline{x_1} - \overline{x_2}}{\sqrt{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)}} \quad (2)$$

$$d = n_1 + n_2 - 1 \quad (3)$$

$$s_1^2 = \frac{\sum_{i=1}^{n_1} (x_i - \overline{x_1})^2}{n_1 - 1} \quad (4)$$

$$s_2^2 = \frac{\sum_{i=1}^{n_2} (x_i - \overline{x_2})^2}{n_2 - 1} \quad (5)$$

where

- t is the Student's t-test
- x_1 is the mean value of first group
- x_2 is the mean value of second group
- s_1 is the standard deviation of first group
- s_2 is the standard deviation of second group
- n_1 is the number of observations in first group
- n_2 is the number of observations in first group

The college students' in-depth learning evaluation scale was delivered to 100 students in the experimental class before and after the teaching experiment to better understand the changes in students' in-depth learning status in the course. Students completed it genuinely based on their

actual learning scenario. This information is analyzed using Python software. Data from the questionnaire's pretest and posttest are collected for an independent sample t-test [21] to compare the means. The formula for independent sample t-test is mentioned in Equation (2)−(5). It can be demonstrated that the use of five dimensions in the deep evaluation model assesses pretty quickly, and their p values are $0<0.01$. It implies that there is a significant difference in the experimental class's deep evaluation model before and after the course implementation. It entirely reflects that the deep evaluation model has significantly upgraded the in-depth learning level of the students in the experimental group, indicating that the students' education perception and creativity are significantly enhanced.

6 Conclusion

College students' evaluation of teaching plays a very important role in the improvement of teaching quality and the optimization of the teaching process. It can help teachers recognize the problems and deficiencies in the teaching process in a timely manner, carry out student-oriented education and teaching activities, better meet students' teaching needs, improve students' learning initiative and enthusiasm, and improve the overall teaching quality of colleges and universities. It can also promote the healthy development and stable progress of colleges and universities. Therefore, it is necessary to pay more attention to the system of college students' evaluation of teaching, clarify the problems and deficiencies in the current process of college students' evaluation of teaching, and take targeted measures to actively solve them, so as to ensure that college students' evaluation of teaching can play its due role and value, and promote the further improvement of college teaching quality. In the future, an effort will be taken to propose a novel method for teaching evaluation in a flipped learning practice. Research will be conducted to evaluate student’s skill in an autonomous learning, application skills and life-long learning.

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